LIGHTNING

Science for the 21st Century ***will include research into the electrodynamics, electric fields and high-frequency radio signals associated with lightning, as well as their optical signals***

Striking Earth 100 times every second, lightning may be not only the most spectacular weather phenomenon we know, but the most familiar as well. Lightning bolts can go from cloud to ground, within and between clouds or from ground to cloud, and can carry electrical charges of 100 million volts and can be deadly. Approximately 100 people are killed by lightning in the United States every year, hundreds more are seriously injured and property damage amounts to millions of dollars.

In the early ‘90s researchers recorded the first visual proof of a strange and beautiful electrical phenomenon, upward lightning — so called jets, sprites and elves — that, in slow-motion video, seemed to puff vividly colored light upwards high above the tops of thunderstorms in the stratosphere. Los Alamos scientists plan to use high-altitude scientific balloons to further the research of this mysterious phenomenon.

The primary lightning research tool used by Los Alamos is FORTE, a satellite launched in 1997 to study optical and radio frequency signals to aid in international treaty verification. FORTE’s capabilities also make it an outstanding platform for the study of lightning. To date FORTE has compiled data on more than three million individual lightning discharges.

Los Alamos coordinates optical observation of lightning with radio frequency observations, continues compiling extensive statistical data on a wide variety of weather and electric field conditions associated with lightning and is developing and expanding a ground-based electric field change detection system, called the Sferic Array. Electric field changes are used to explore the mechanism thought to be at the heart of lightning. Strong bi-polar impulses measured inside clouds reveal these emissions as a function of altitude, total charge produced in a thunderstorm, charge density, charge separation and charging rate. These and other factors must be understood together to build a complete picture of lightning.

Changes in the electric field of clouds also give rise to CIDs, or compact intercloud discharges, which are detected by the Sferic Array. These allow scientists to examine the characteristics of thunderstorms that are prolific producers of CIDs and compare them to thunderstorms that produce few, if any, CIDs and correlate that to the amount of lightning produced by a given thunderstorm. This information can begin the process of understanding why one thunderstorm produces a vast amount of lightning while another yields no lightning at all.

Using the optical and radio frequency detectors on FORTE in concert with ground-based detection and characterization technologies, scientists are building the ability to pinpoint the location of lightning strikes and correlate the electrodynamics and atmospheric conditions that are present with lightning. Researchers hope to one day build a large enough data set so that an accurate predictive model can be created to provide a space-based global early warning capability that can help protect people during severe weather anywhere on Earth.

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